A Coupled Climate Model Based on an Eddy-Permitting OGCM

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Content

- Introduction to LASG/IAP Climate Ocean Model
- Basic Simulation of LICOM
- Coupling Experiment Based on LICOM
- Summary

Ocean Models in LASG

4-L OGCM (Zhang et al., 1989)
20-L OGCM (Zhang et al., 1995)
L30T63 OGCM (Jin et al., 1999)

LASG/IAP Climate Ocean Model

LICOM1.0 (Liu et al., 2002)

Why develop an eddy-permitting OGCM ?

- Resolve the equatorial wave guide in order to investigate tropical air-sea interaction
- Resolve the complex topography in order to improve the simulated western boundary current system such as Indonesian Through Flow

LASG/IAP Climate Ocean Model LICOM

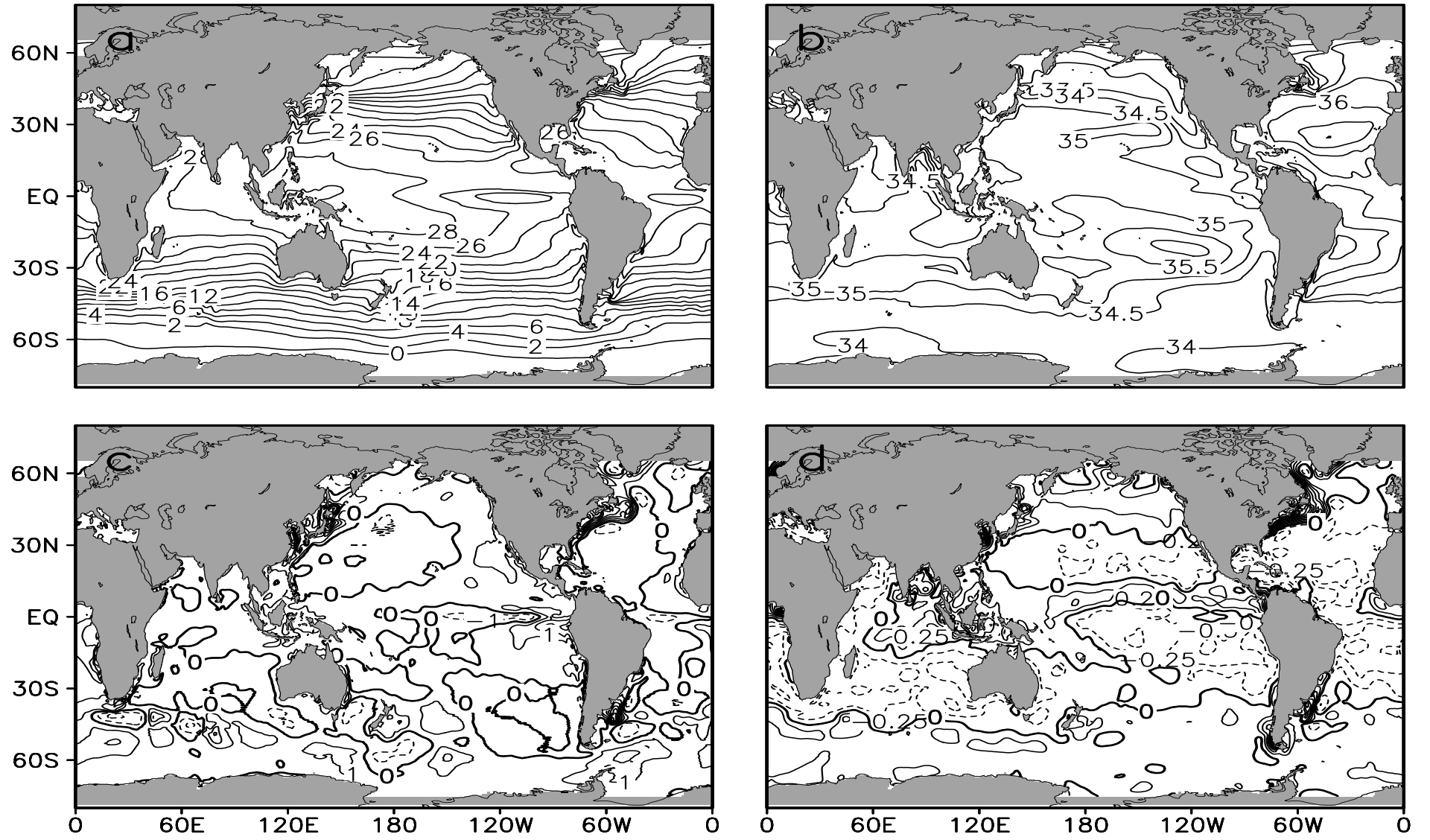
- 3-D primitive equation OGCM with free surface and “ η ” coordinate.
- Flexible resolution up to 0.5 degree.
- GM90, PP etc.
- Parallel Fortran 90 source code with mixed MPI and Open MP. (24 yrs/per day on one node of IBM SP690 or 72 nodes of Linux PC cluster)
- Climatology wind stress and heat flux from ERA
- Restoring boundary condition for salinity

SST

unit:°C

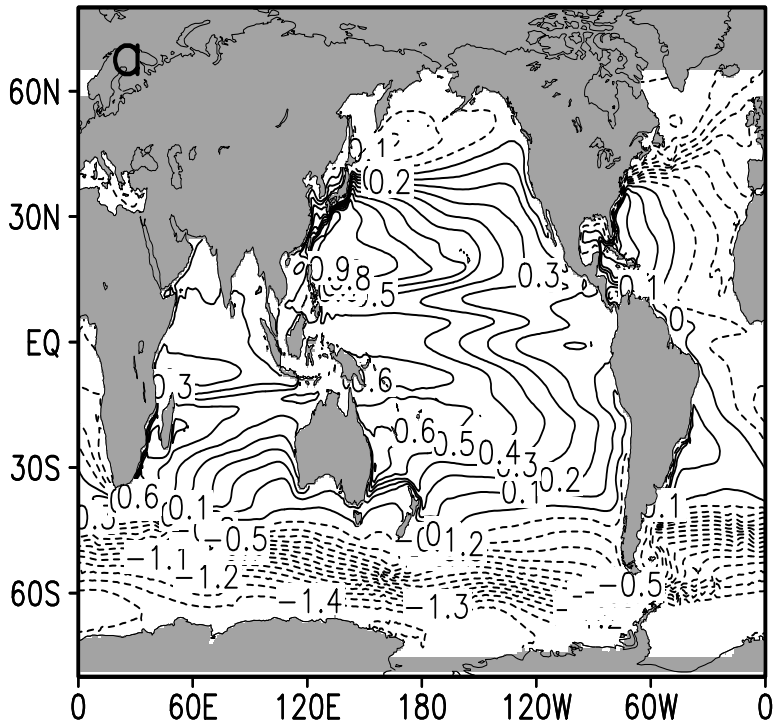
SSS

unit:psu



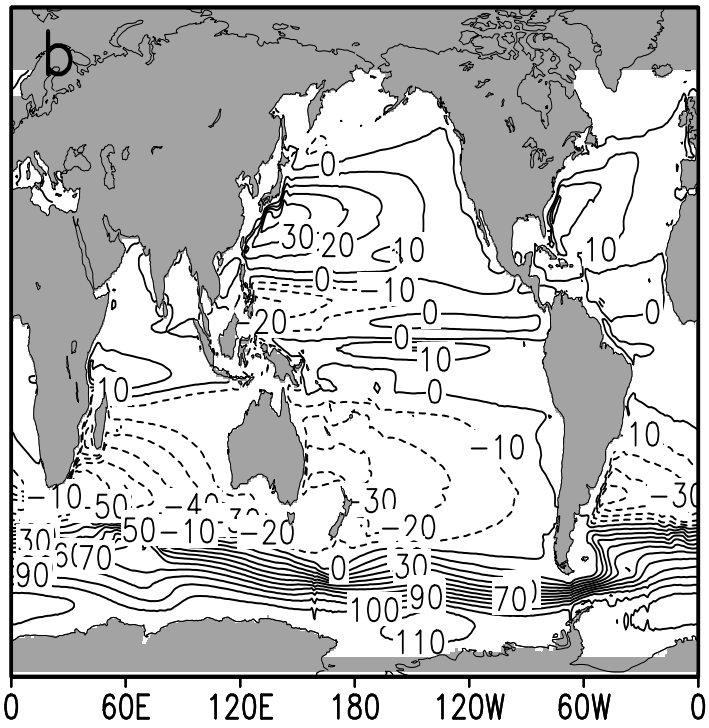
Sea Surface Height

unit:m

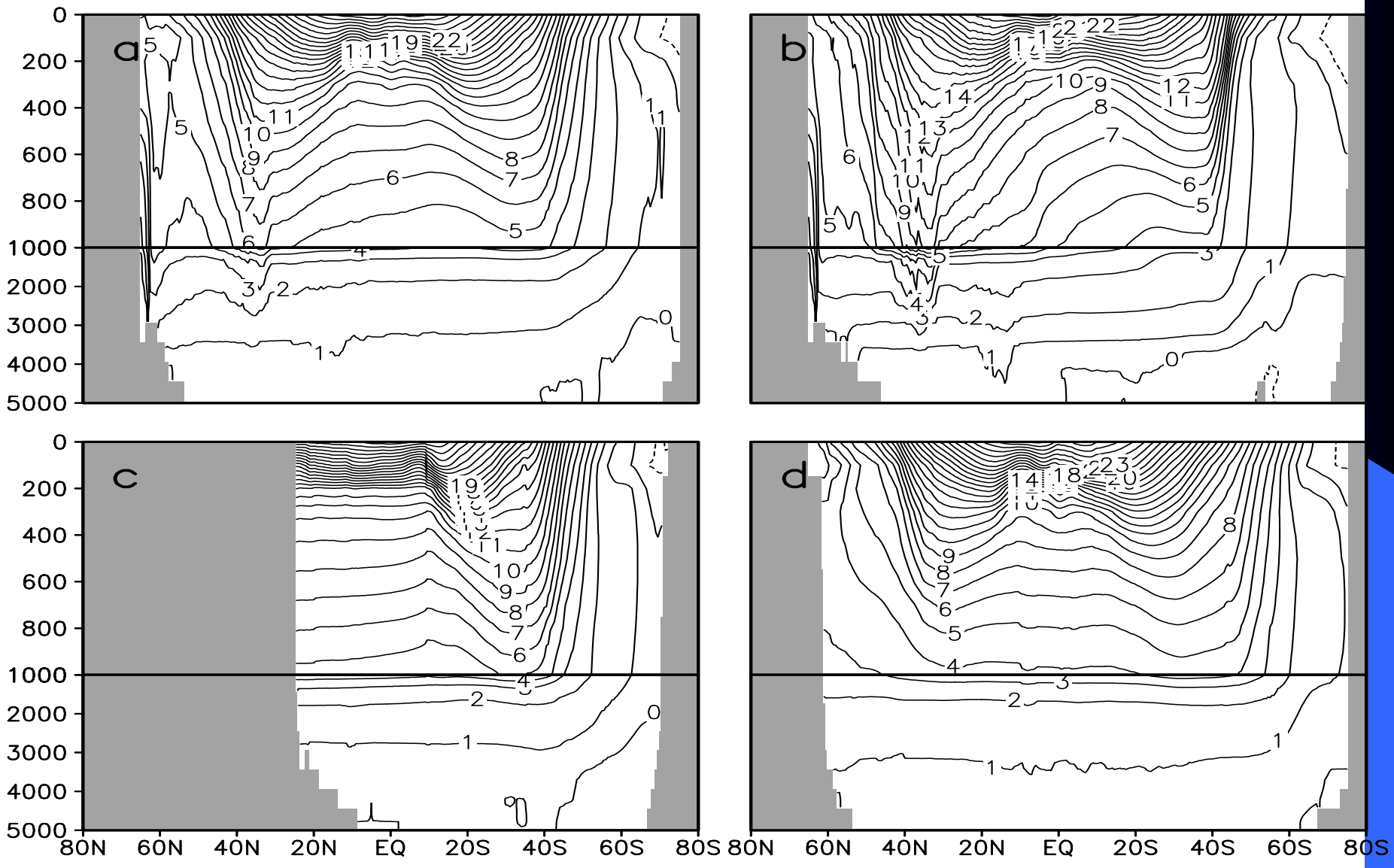


Barotropical Stream Function

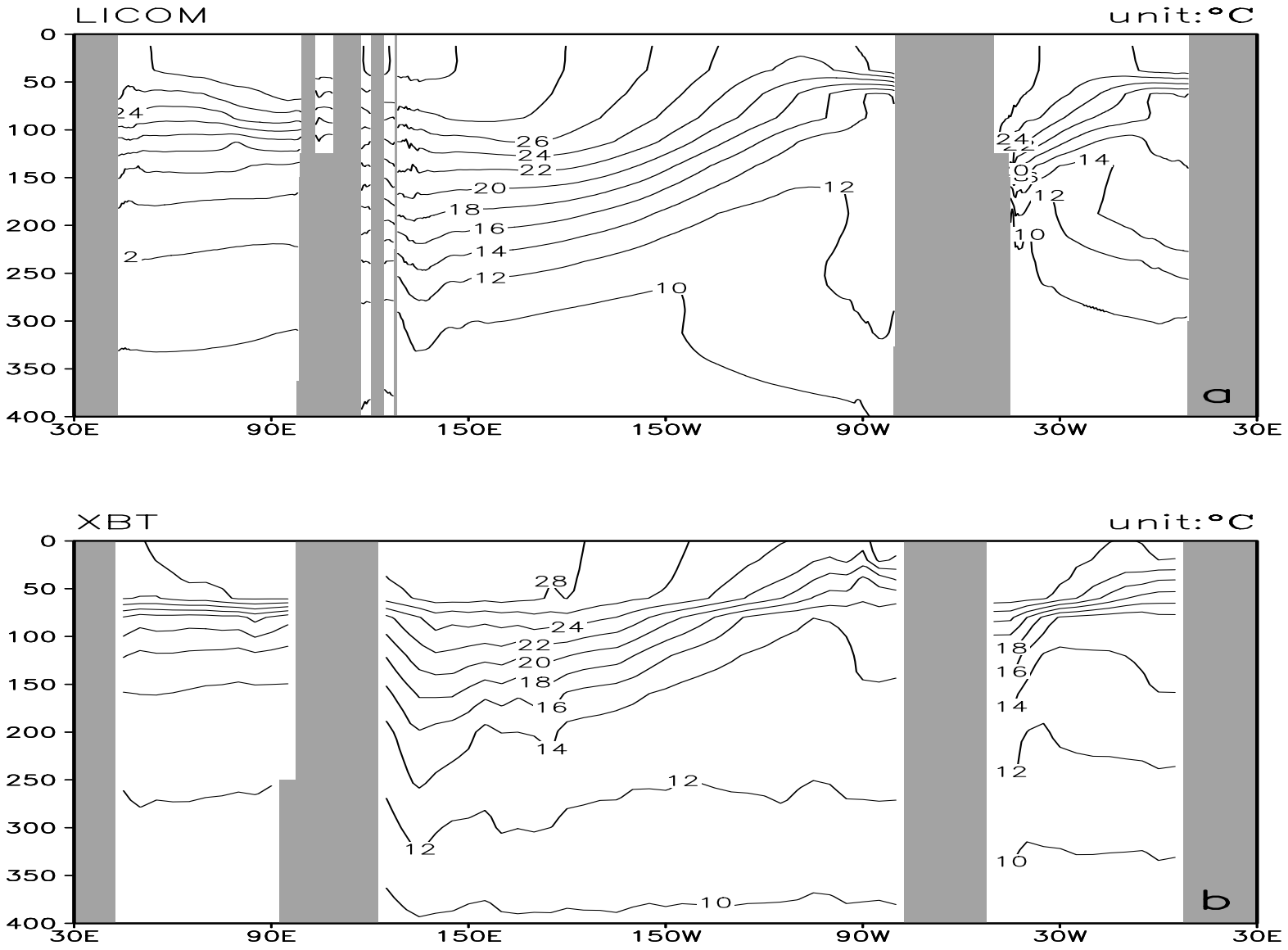
unit:Sv

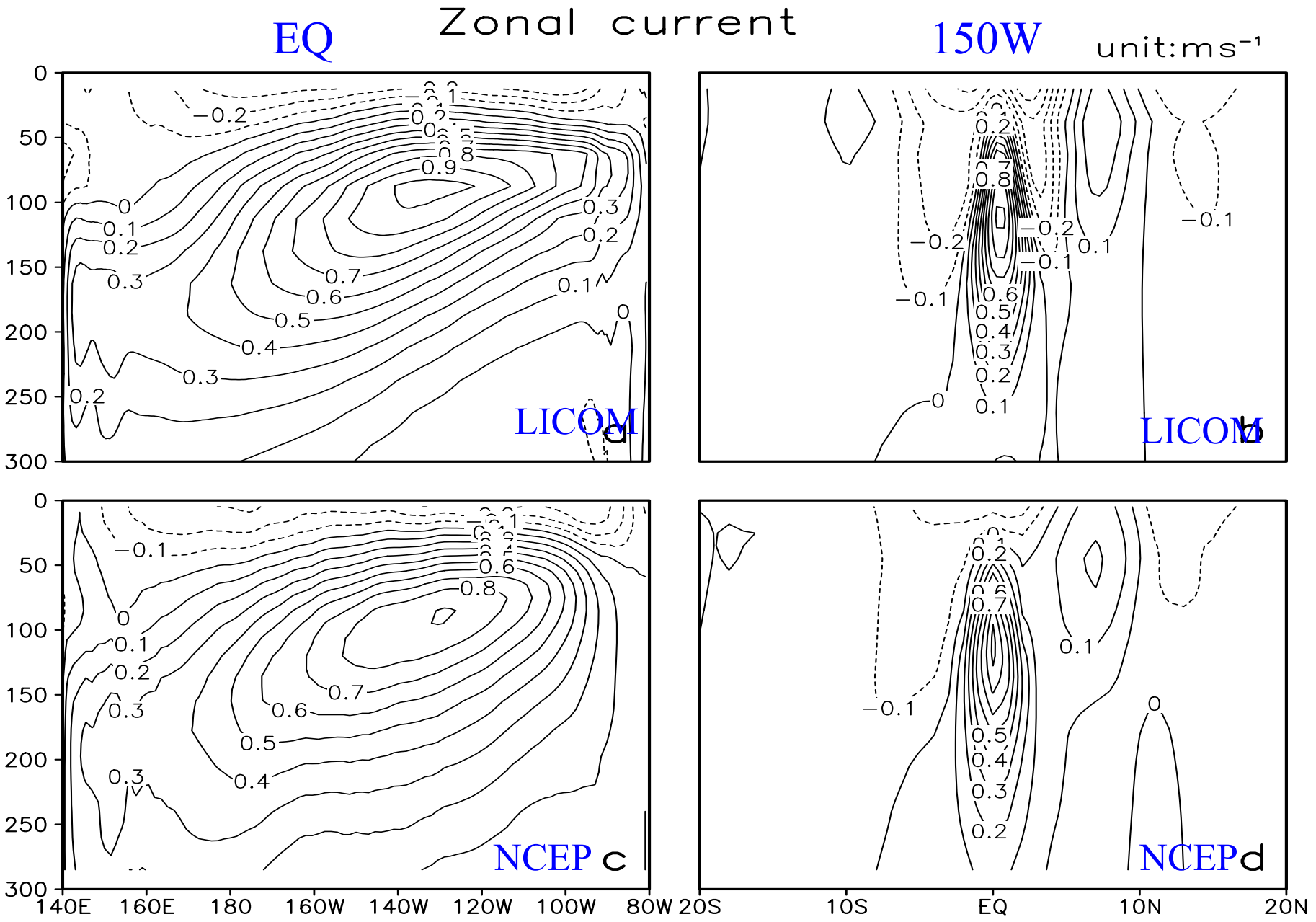


Zonal mean temperature



Longitude-Depth Section of Temperature along Equator



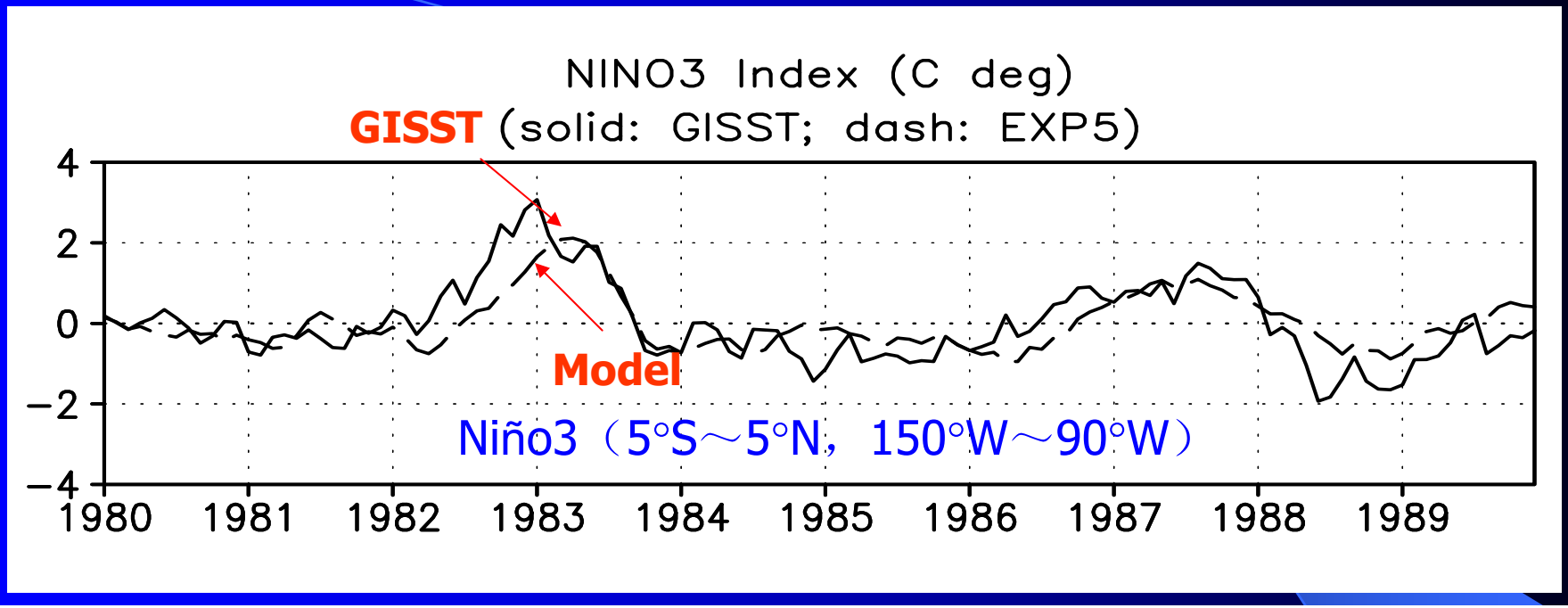

Zonal current
EQ
150W
unit:ms⁻¹
LICOM a
LICOM b
NCEP c
NCEP d
0
50
100
150
200
250
300
140E
160E
180
160W
140W
120W
100W
80W
20S
10S
EQ
10N
20N

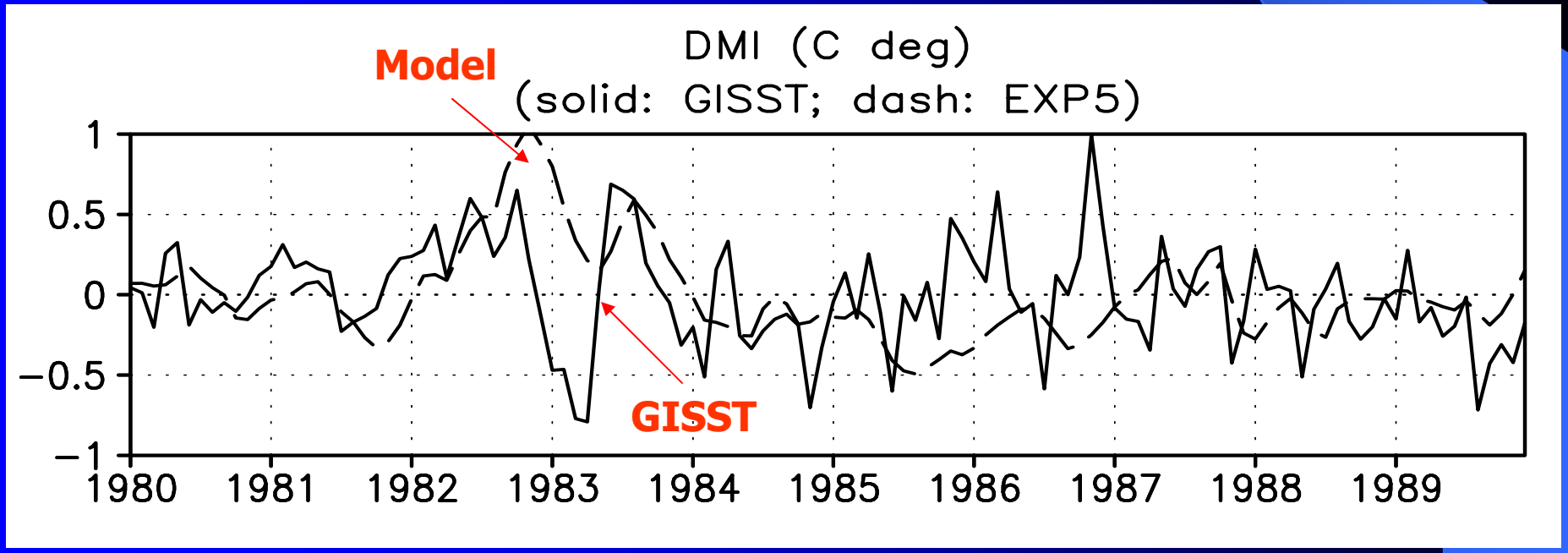
Observed and Simulated ITF

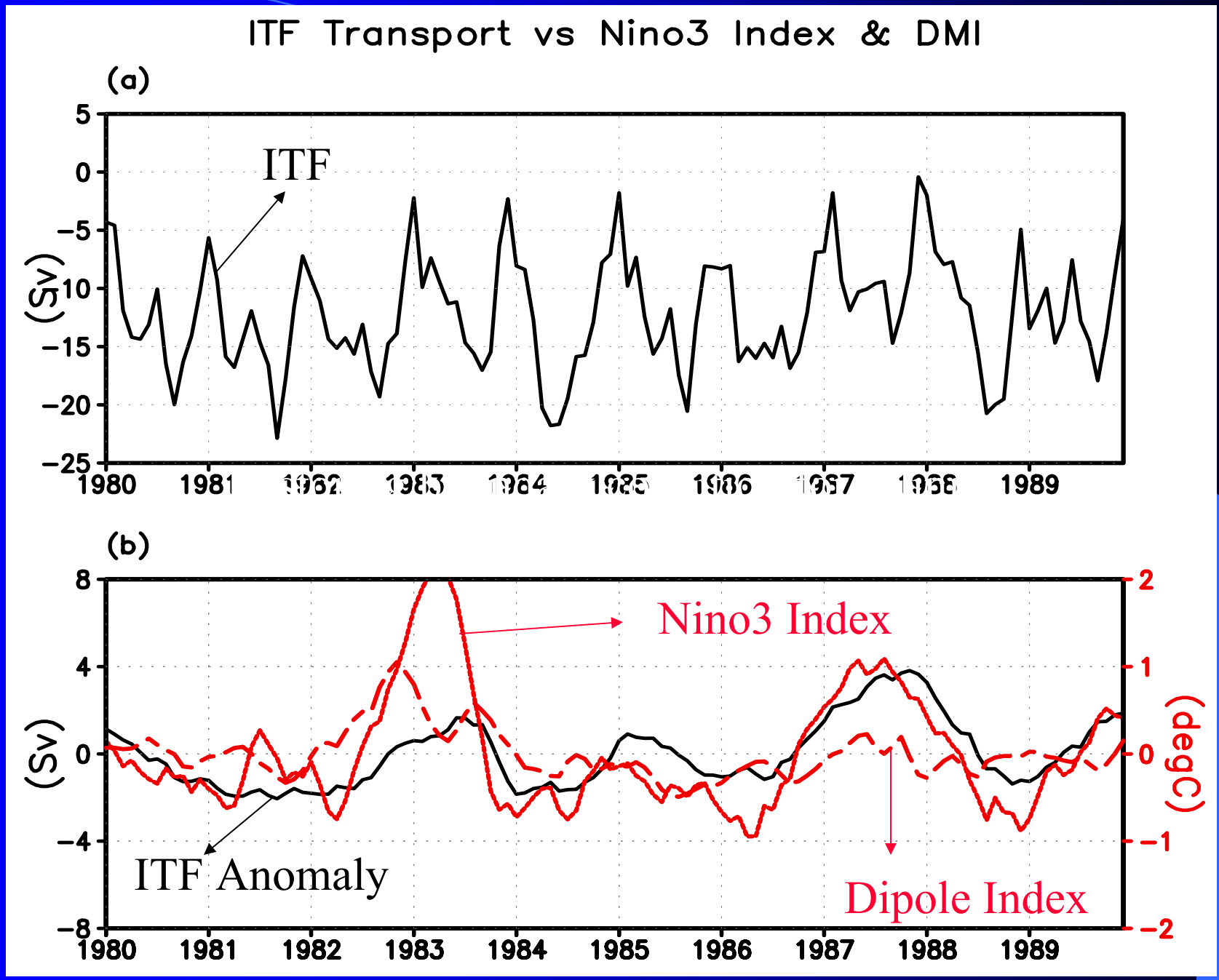
	Mass (1)	Makassar (4)	Torres (2)	Karimata (3)	Lombok (6)	Ombai (7)	Timor (8)
Model	-12.2	-6.5	-1.1	—0.5	-5.1	-5.9	-0.02
OBS	-12 [1]	-9.3 [2]	0.1	-	-1.7 [3]	-5 [4]	-4.5 [5]

Simulation of Interannual Variability with LICOM

Surface Forcing:
Daily wind stress from ERA for 1979-1993


NINO3 Index (C deg)
GISST (solid: GISST; dash: EXP5)
Model
Niño3（5°S～5°N，150°W～90°W）
4
2
0
−2
−4
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989


Model
DMI (C deg)
(solid: GISST; dash: EXP5)
GISST
1
0.5
0
−0.5
−1
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989


ITF Transport vs Nino3 Index & DMI
(a)
ITF
(Sv)
5
0
−5
−10
−15
−20
−25
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
(b)
Nino3 Index
ITF Anomaly
Dipole Index
(Sv)
(degC)
8
4
0
−4
−8
2
1
0
−1
−2
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989

Coupled Models in LASG

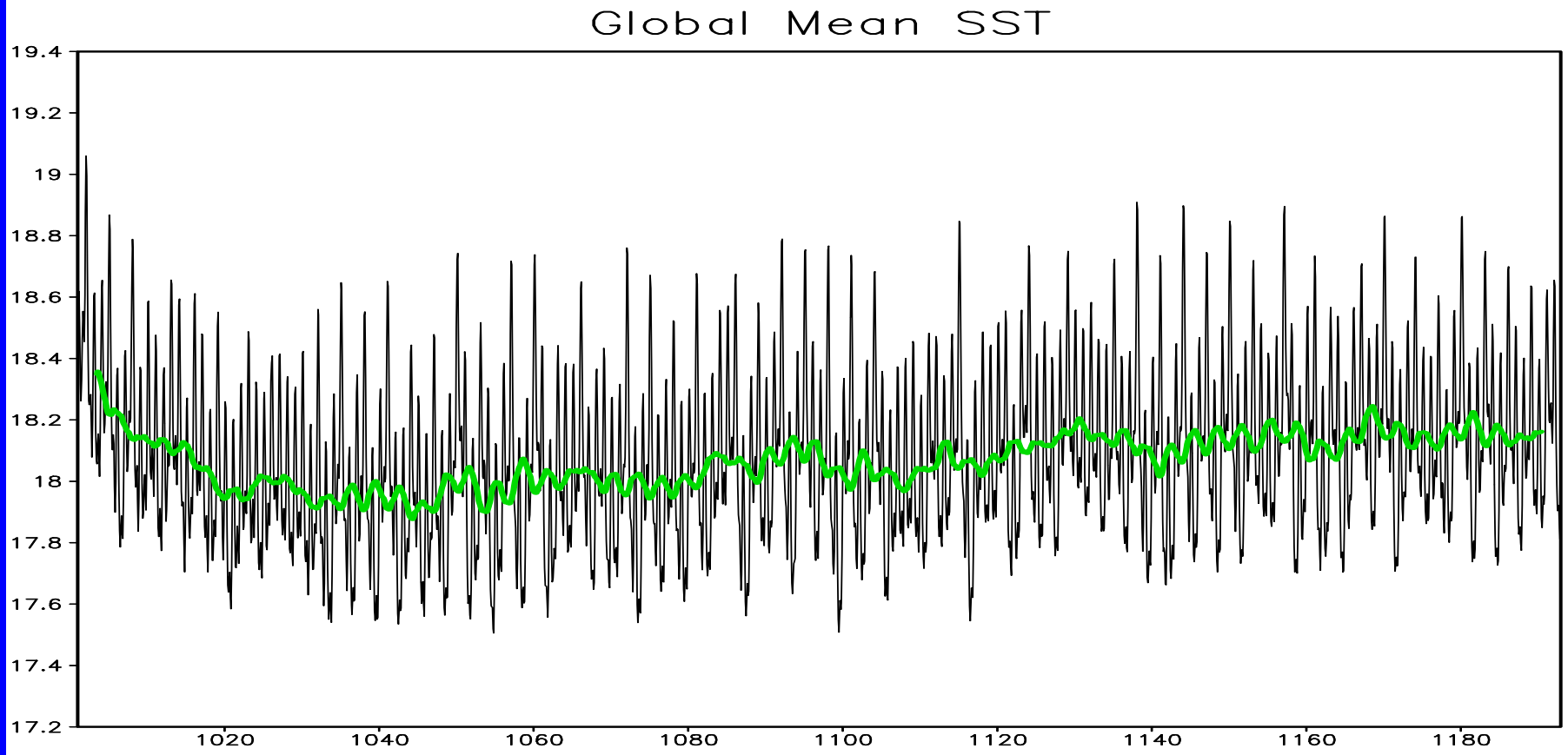
M2+4 (Zhang et al., 1992)
M2+20 (Chen et al., 1996)
GOALS (Jin et al., 1996; Yu et al., 1997)
T63AOGCM (Yu et al., 1999)
FGCM-0 (Yu et al., 2002)

FGCM-1 (Yu et al., 2003)

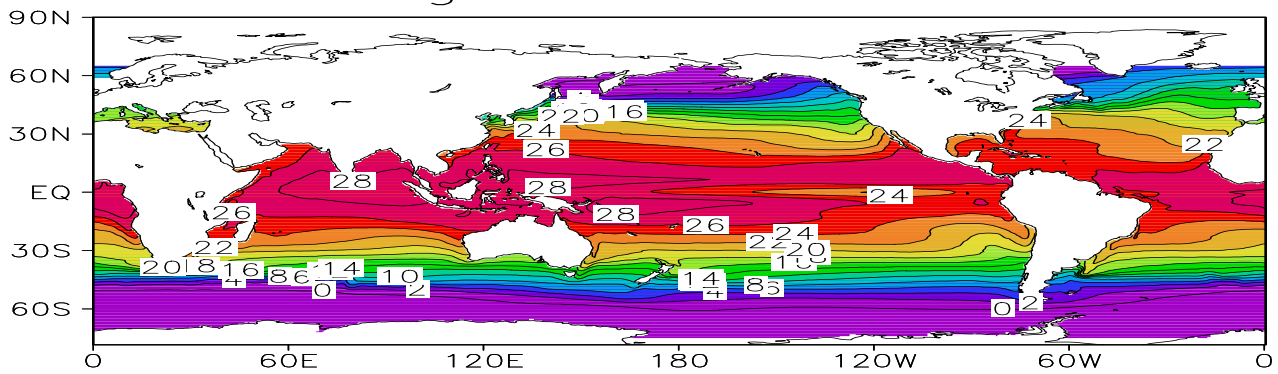
FGCM Version 1.0 in LASG

- High resolution OGCM (0.5°X0.5°)--LICOM
- NCAR CAM2
- NCAR CLM
- NCAR Sea Ice Model
- NCAR Flux Coupler 5

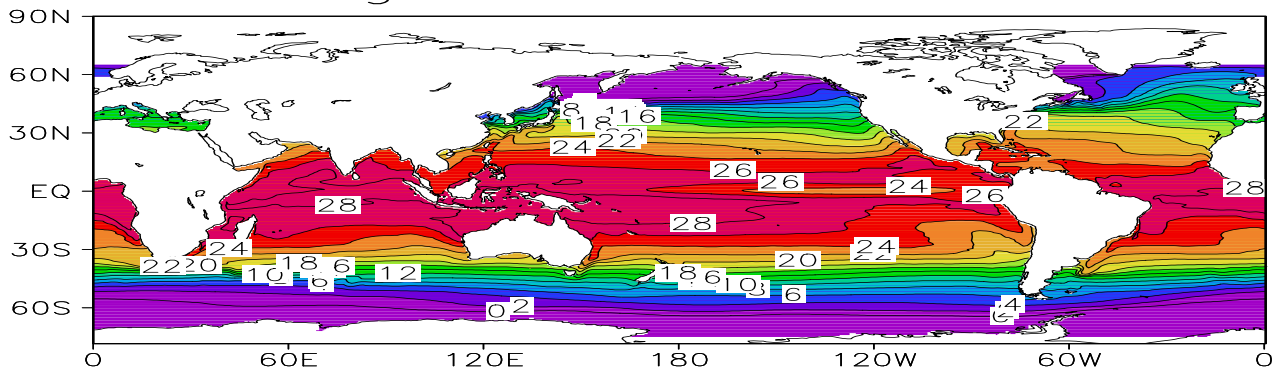
Global Mean SST from FGCM-1.0



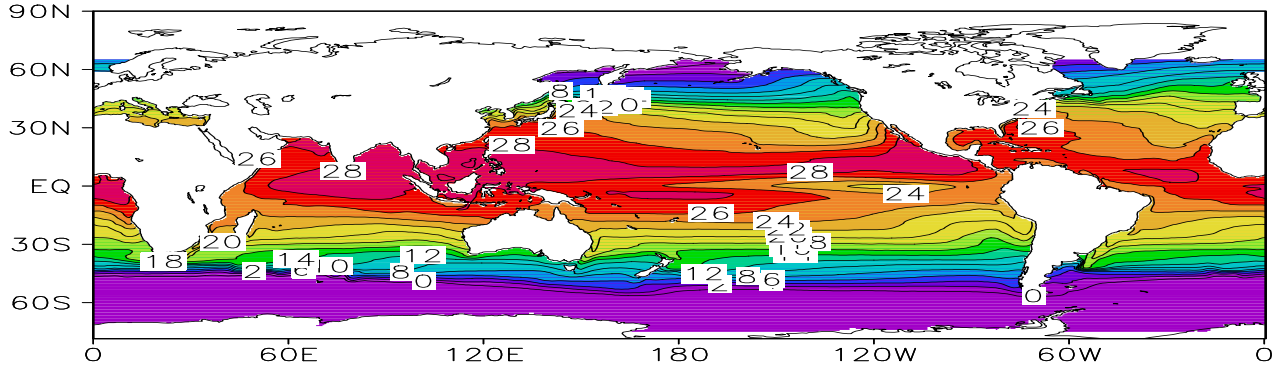
Climatological Annual Mean SST



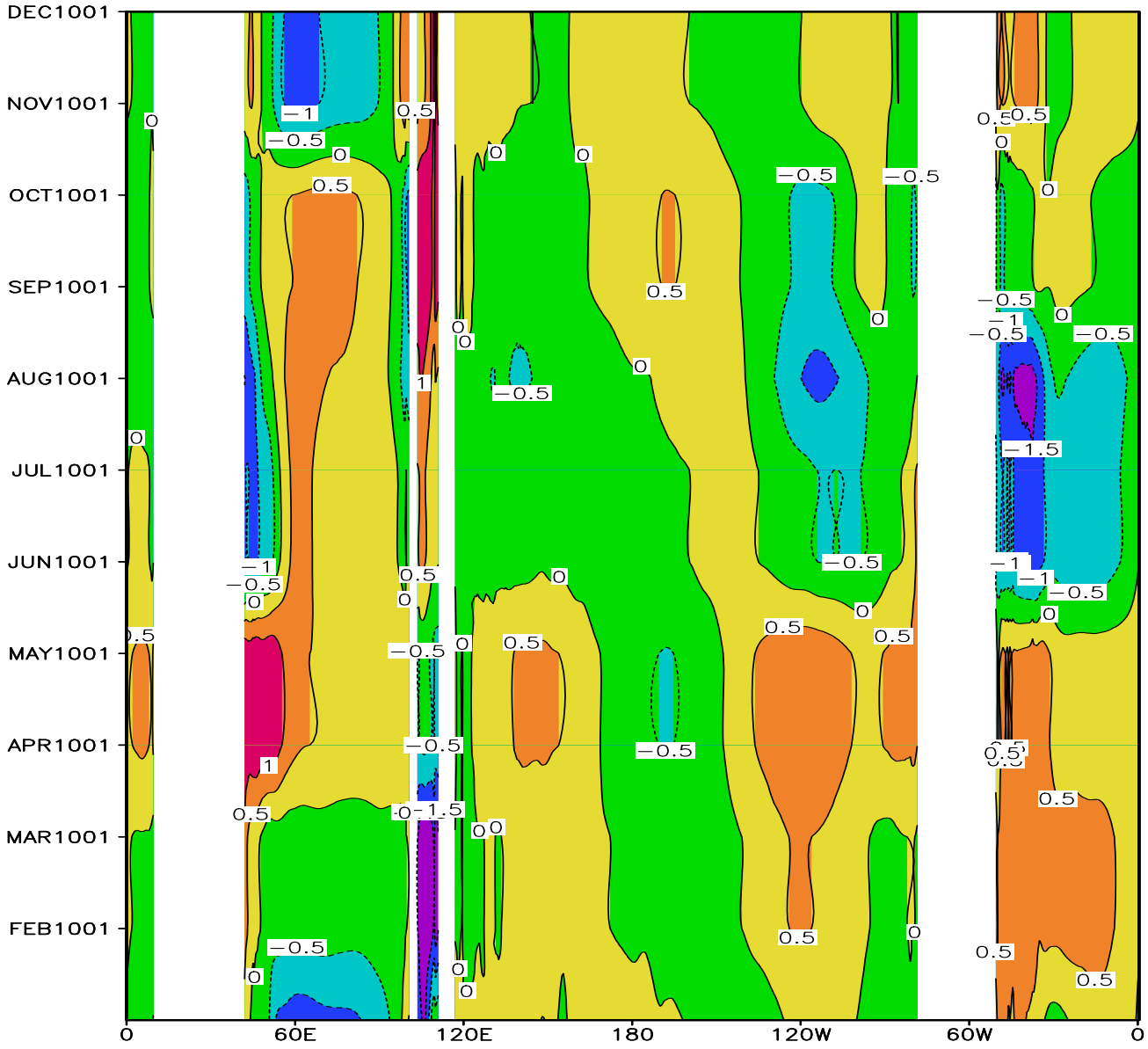
Climatological Mean SST for March



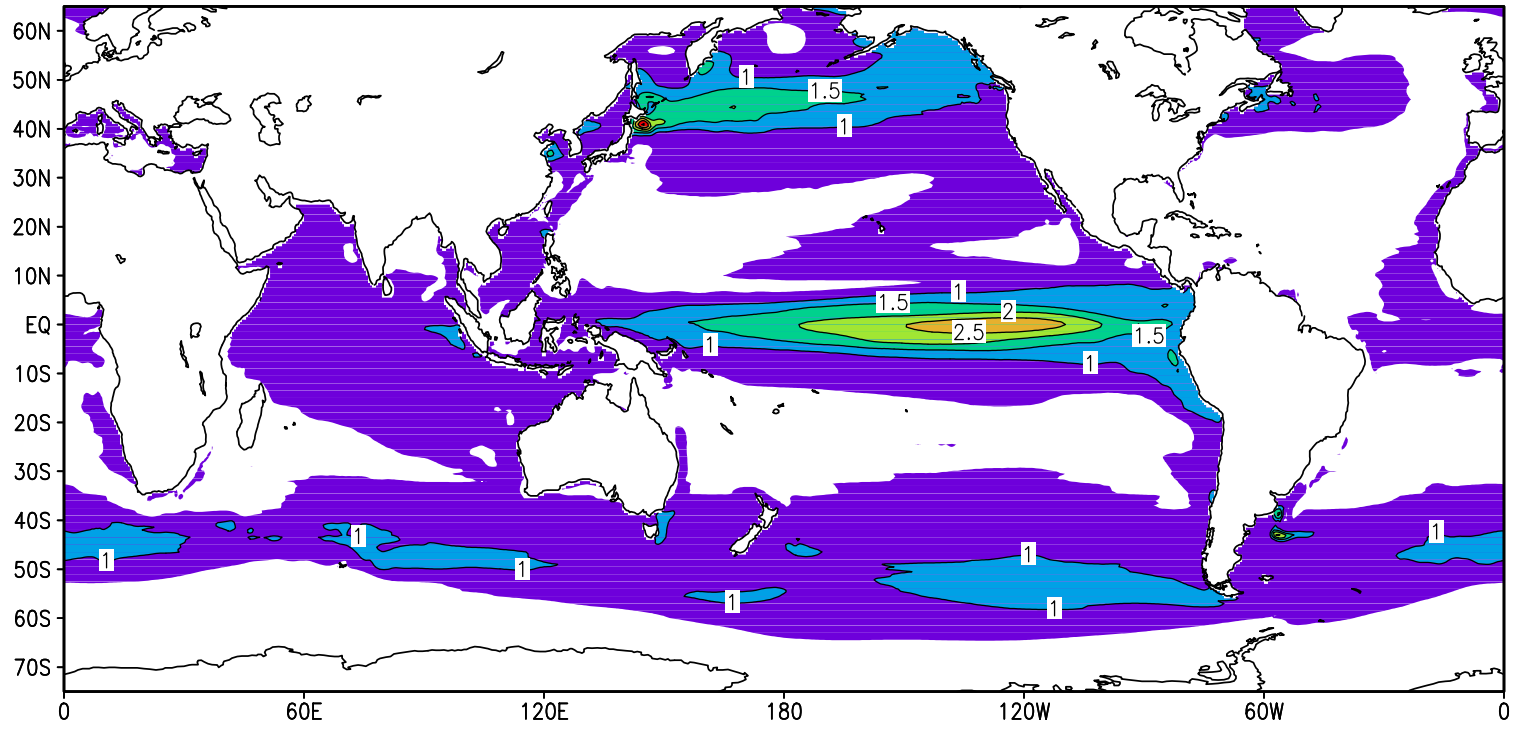
Climatological Mean SST for September



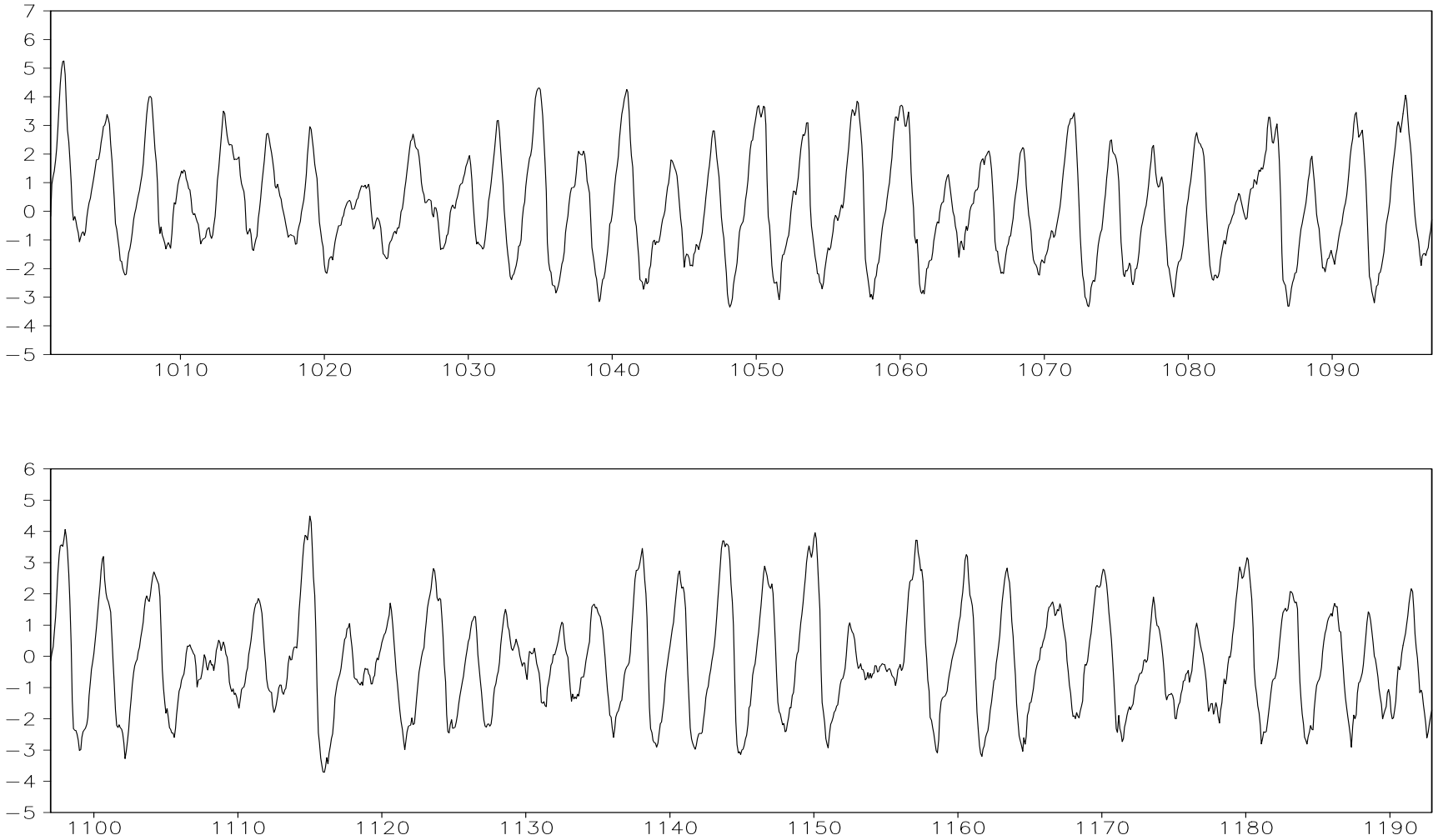
Seasonal Cycle of SST in the Equatorial Oceans



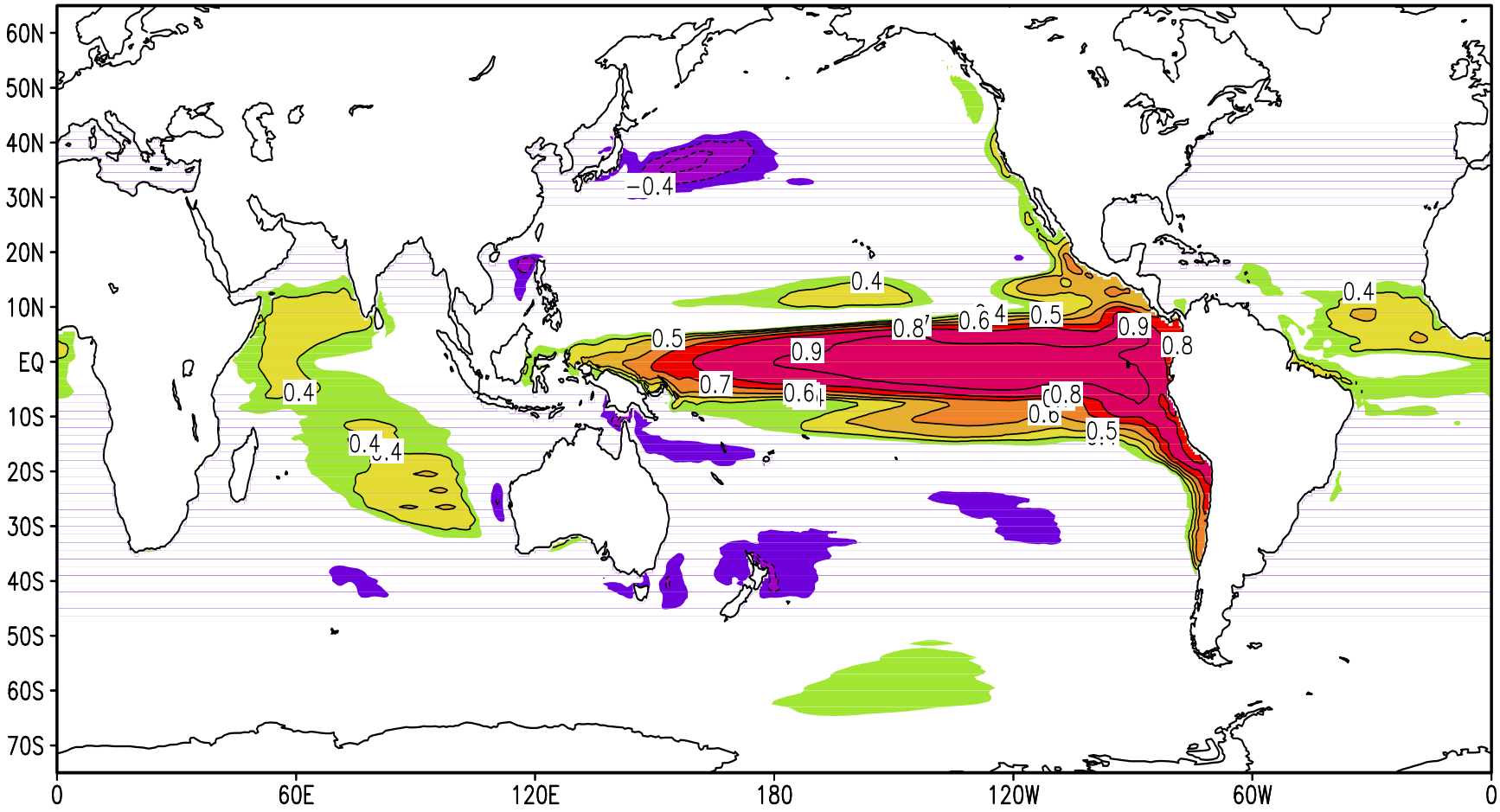
Standard Deviation of SST from FGCM-1.0



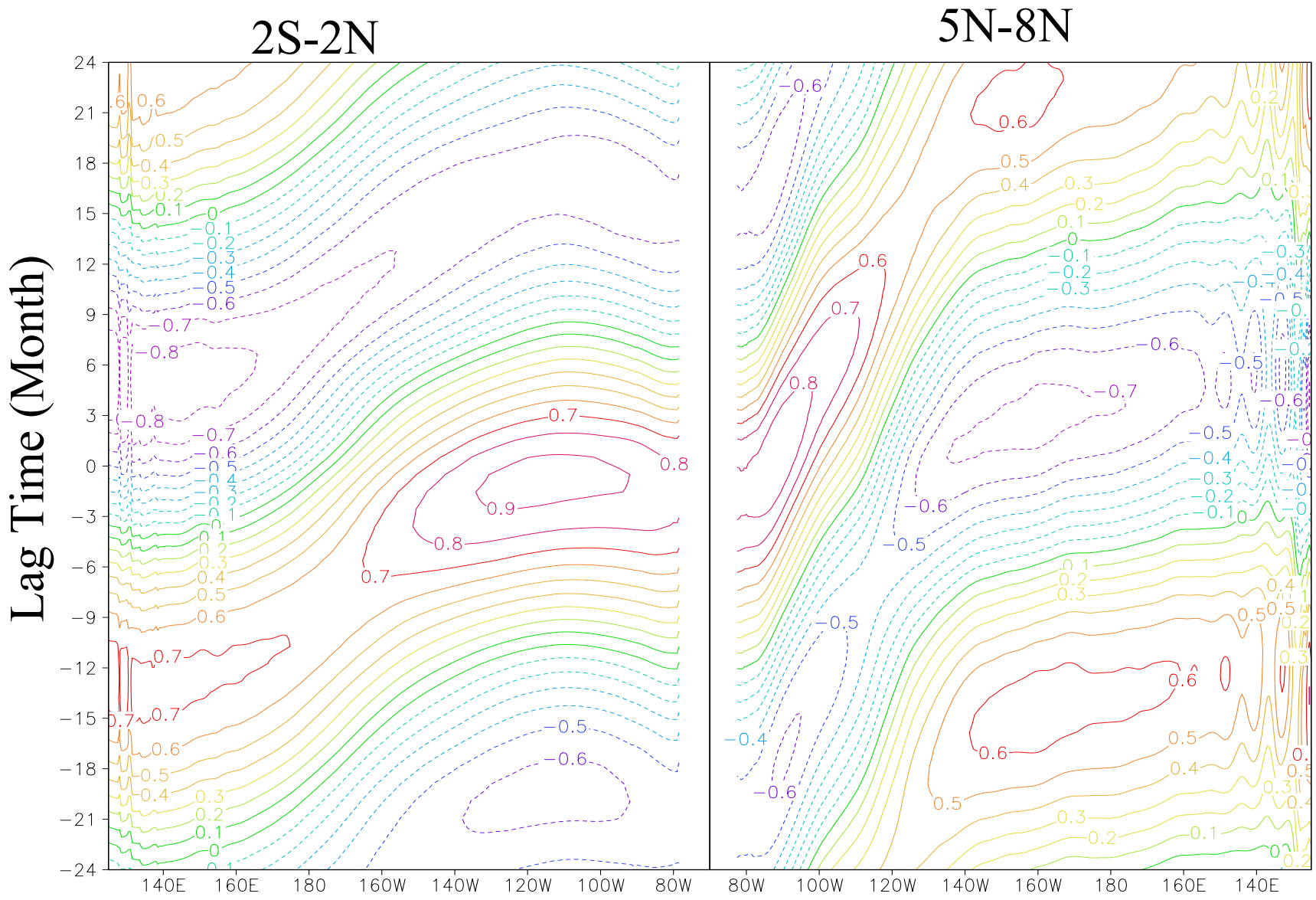
Nino3 Index


7
6
5
4
3
2
1
0
−1
−2
−3
−4
−5
1010
1020
1030
1040
1050
1060
1070
1080
1090
6
5
4
3
2
1
0
−1
−2
−3
−4
−5
1100
1110
1120
1130
1140
1150
1160
1170
1180
1190
Model Year

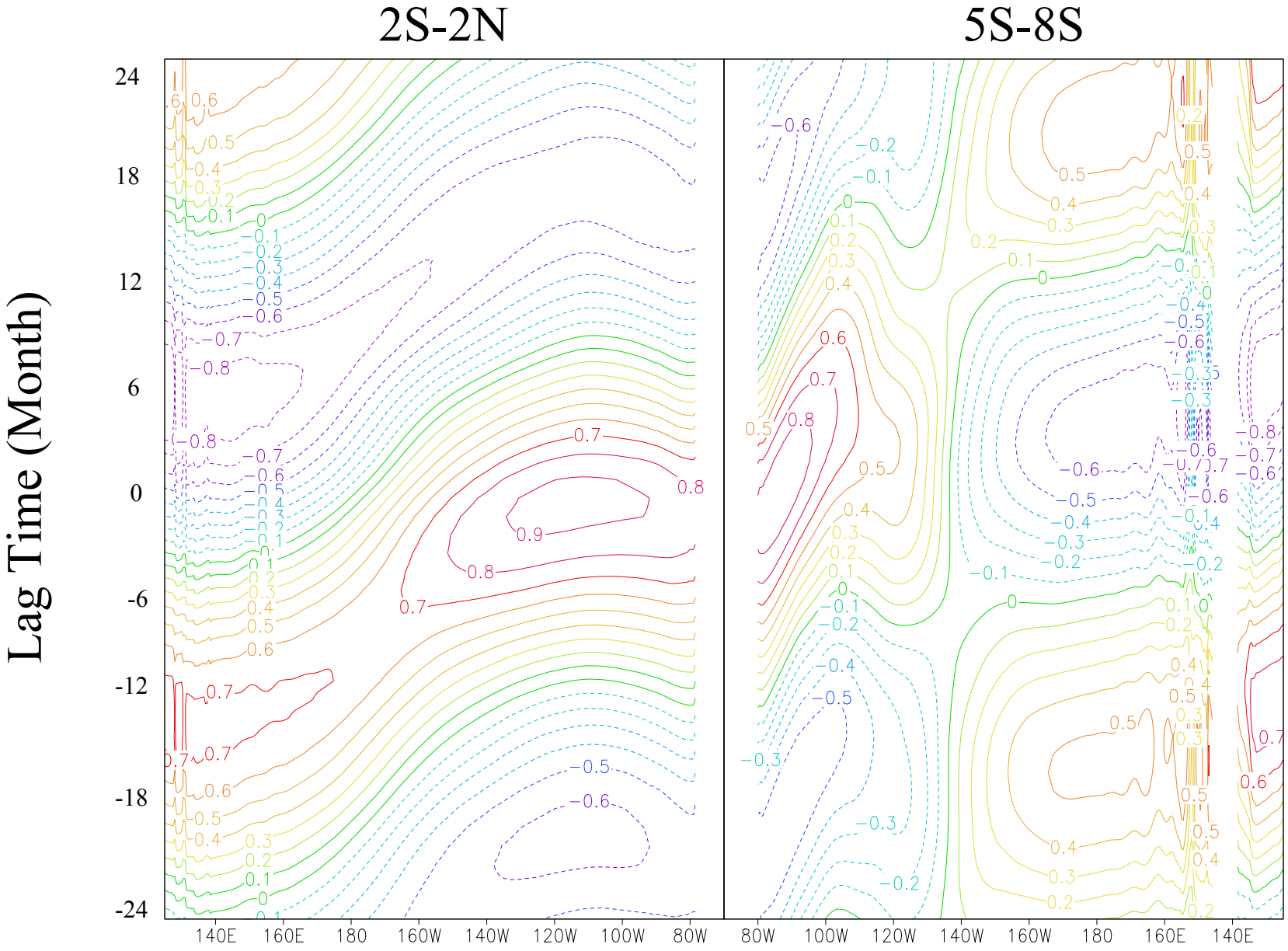
Correlation between SST and Nino3 Index



Lag Correlation between Nino3 Index and Upper Ocean Heat Content



Lag Correlation between Nino3 Index and Upper Ocean Heat Content



Summary

- An eddy-permitting OGCM has been developed in LASG, which is highly modular model, especially it is designed to run in the different computer system , and it is easy to modify resolution, topography, switch the different parameterization sachems for any purpose.
- Based the ocean model LICOM, we also developed the new version of coupled model, FGCM-1.0, which can produce the reasonable large-scale climatology pattern as well as the interannual variability such as ENSO events.